WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005FL101B

Title: Mechanisms and Modeling of Soft-Bed Nutrient Release in Lakes

Project Type: Research

Focus Categories: Non Point Pollution, Nutrients, Sediments

Keywords: Contaminant transport, eutrophication, lakes, nutrients, suspended sediments, water quality modeling, waves, wind

Start Date: 03/01/2005

End Date: 02/28/2006

Federal Funds: $26,531

Non-Federal Matching Funds: $53,356

Congressional District: 10th

Principal Investigator:
Ashish J. Mehta

Abstract

Numerous soft, muck-laden lakes in Florida are highly trophic, with several containing toxic biogenic substances slated for restoration. A key issue underlying water quality in such lakes is the episodic loading of the water column by the release of sequestered nutrients and other constituents under the action of wind waves and accompanying entrainment and settling of the bottom sediment. In modeling release, it is common to assume that the bed is fixed and the flux is Fickian with a diffusion coefficient determined from laboratory tests or, much more commonly, by calibration against measured time-series of site-specific constituents. This so-called fixed-bed paradigm is acceptable for hard beds but bears little relation to the physics of constituent exchange at the soft fine sediment-water interface. There, wave-induced heaving and destabilization of interfacial integrity under high-energy events determine the rate of release, and tend to subsume the release rate governed by the fixed-bed mechanism.

In a wave flume study, we examined the mechanisms that contribute to the release of dyes used as constituent surrogates. A significant finding of that study was that a thin diffusive sublayer plays a dominant role in controlling the rate of release of the dye (sequestered in the bed and acting as a constant source) into the ambient water column.

While this finding is consistent with the low level of wave-induced boundary layer turbulence present in the flume, one may expect the role of the sublayer to change with increasingly turbulent boundary layer. Thus a prototype investigation quite essential for addressing scaling effects if one is to apply the new understanding of the constituent release process in modeling the nutrient dynamics of lakes.

Recently, under a separate study we have collected 266 days long time-series of hydrodynamic parameters, TSS concentrations and nutrient (P and N) concentrations in the hypereutrophic Newnans Lake in north-central Florida. We propose to extend the data collection study, which has ended, by injecting one or more dyes in the soft sediment and measuring their release as a function of wind speed. These tests, along with information on the density and composition of the bottom sediment, will then be used to examine the role of the diffusive sublayer in governing constituent release. A fully three-dimensional numerical code will be used to model lake dynamics for the purpose. This work, which is expected to lead to a doctoral dissertation, aims to replace the fixed-bed flux model with a much more realistic description of nutrient release at soft muck bottoms. A companion aim or the proposed study is to develop an operational model for nutrient dynamics in lakes laden with soft sediments. This tool will also serve as our means for information transfer.